

**Bulk-sensitive photoemission for Pr-based heavy fermion  
and Spin-polarized scanning tunneling spectroscopy  
for Fe nanomagnets**

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The Bulk-sensitive measurement must be crucial in the study of Pr 4f states since the c-f hybridization in Ce, Sm, and Yb compounds is known to be much weaker at the surface than in the bulk. We have performed the high-resolution bulk-sensitive Pr 3d-4f resonant photoemission spectroscopy ( $h\nu \sim 930\text{eV}$ ) and Pr 3d core-level spectroscopy up to  $h\nu = 5500\text{eV}$  for heavy-fermion Pr compounds. We have observed the Kondo resonance for PrFe<sub>4</sub>P<sub>12</sub>, at Fermi level the intensity of which is much stronger than that observed in the low-energy photoemission measurements. The contribution of 4f<sup>3</sup> configuration is obviously seen in Pr 3d core-level spectra, suggesting the Kondo resonance originates from the mixing of 4f<sup>2</sup> and 4f<sup>3</sup> configurations due to the strong hybridization.

In addition, I will show the recent results of spin-polarized scanning tunneling spectroscopy (Sp-STS) for Fe nanomagnet on W(001). Single domain and vortex states in the nano-scale islands have been observed. The high-resolution magnetic images enable us to determine the size limit of the single domain experimentally.

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